HYDROGEOMORPHIC ASSESSMENT (HGM) FOR POTENTIAL MITIGATION SITES FOR THE PROPOSED 2,420-ACRE SEVEN HILLS SURFACE MINE, WARRICK COUNTY, INDIANA

(IDNR SURFACE MINING APPLICATION # S-00357)

Prepared for:
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Warrick County, Indiana

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1 Introduction

This mitigation site assessment complements the hydrogeomorphic assessment (HGM) performed on the Seven Hills Mine in Warrick County, Indiana. The scope of this phase is to assess both on-site and off-site areas for wetland compensatory mitigation opportunities needed as a result of proposed mining disturbance. The focus of this project is to utilize the HGM process as a tool to attempt to quantify wetland function loss from the proposed action and subsequent gain as part of restoration/enhancement initiatives. Ultimately the derived values are used to determine the "no net loss" point at which mitigation equals impact.

Eco-Tech personnel inspected wetlands within the permit boundary and six off-site potential mitigation areas in December, 2006 (Appendix A, Figure 1: Appendix B). The off-site areas included one emergent wetland, three forested wetlands, one upland area, and one upland/wetland forest complex, all within the Pigeon Creek drainage. All sites preliminarily were evaluated using the Hydrogeomorphic Approach (HGM). Only those with the potential for sufficient mitigation credit gain are described further in this report. Refer to HYDROGEOMORPHIC ASSESSMENT (HGM) FOR THE PROPOSED 2,420 ACRE SEVEN HILLS SURFACE MINE, WARRICK COUNTY, INDIANA (IDNR SURFACE MINING APPLICATION # S-00357) for complete description of methods used for HGM assessment.

For each site, a Functional Capacity Unit (FCU) was derived. The FCU is a quantified value of the functionality of wetlands. It is calculated by multiplying the mean Functional Capacity Index (FCI) by the number of acres of the wetland type. The FCU is used to quantify the amount of gain or loss in wetland function, to establish restoration goals for created or enhanced wetlands, and to determine the amount of credit or deficit resulting from restoration efforts. The net balance determines the area necessary to mitigate during wetland restoration or enhancement. Additionally, this assessment methodology defines quantifiable success criteria and thresholds to be met during the monitoring phase.

2 Seven Hills Permit Area Proposed Wetland Impacts

Figure 2 (Appendix A) illustrates the proposed impact area within the Seven Hills Mine permit boundary. The total proposed impact area consists of approximately 900 acres, of which approximately 446 acres are wetlands. Using a weighted average FCI value of 0.88, 406.19 FCUs are proposed to be impacted by surface mine activities (Table 1). The large forested wetland is the highest rated wetland type (FCI = 0.89), while the remaining 39 acres of proposed impacted emergent and shrub/scrub wetlands have a mean FCI of 0.76. The wetland types and sequences are referenced from the original jurisdictional waters determination for the Seven Hills Mine.

Table 1. Summary of proposed wetland impacts within the Seven Hills Permit Area.

Wetland type	Area (ac)	FCI	FCU
PEM 1	3.99	0.68	2.71
PEM 2	0.93	0.68	0.63
PFO 1	407.22	0.89	362.50
PSS 2	1.44	0.79	1.14
PSS 3	0.38	0.79	0.30
PSS 4	0.47	0.79	0.37
PSS 5	2.08	0.79	1.64
PSS 6	11.50	0.79	9.09
PSS 7	18.36	0.79	14.50
Total	**446.37**		**392.89**

3 Mitigation Site Assessment

Potential credit to be gained at each mitigation site was determined by estimating the FCI scores at Year 0 (post-mining on-site estimations and current measured values for off-site) and subtracting them from the Year 5 proposed scores (post-restoration at conclusion of monitoring period). Several issues were considered such as mine land reclamation, restoration activities, vegetative succession, and monitoring period maintenance.

3.1 On-site Restoration (Seven Hills Permit Area)

Post mining mitigation of the disturbed wetlands presumes that the lowest FCI score possible (0.0) will occur immediately after mining (Year 0). An FCI score of 0.0 indicates that the permit area will have no wetland function as defined within the parameters of this analysis. It is assumed that without the regulatory wetland compensation requirement, normal mine land reclamation would not be favorable for the large-scale development of wetland hydrology and subsoil properties. Excessive subsurface drainage, heterogeneous soil profiles, and surface compaction would prohibit hydrophytic vegetation colonization, making the site similar to other mined/farmed floodplains in the area.

Restoration of a site with a functional capacity index of 0.0 requires the targeted development of wetland hydrology and a low-permeability soil profile. Only then can wetland vegetation be established. We make several assumptions about the restoration of wetlands on minelands that were subsequently considered in the evaluation of functional capacity (Table 2) within the 5-year monitoring period. These include:

- Replacement of floodplain sub-strata following coal seam removal will not raise the current overall elevation of the floodplain and inhibit connectivity to drainage features

- Soil B-horizon will be established uniformly with sufficient clay/silt content so as to maintain low porosity and permeability for the formation of perched water table.

- A and O-horizon (topsoil) material will be stockpiled during mining activities and re-spread evenly and without compaction.

- The floodplain surface will be left with heterogeneous features (swales, depressions, hummocks, etc) to mimic natural macro and micro-topographic roughness.

- Surface drainage features will be constructed incorporating natural channel design principals.

- Coarse woody debris from tree clearing operations will be stockpiled and redistributed during reclamation activities.

- Tree and shrub species conforming to reference lists from the HGM document will be planted.

- Herbaceous species also from the reference list will be seeded where appropriate.

- Some thinning of volunteer woody species and ground cover maintenance will be performed.

- At five years we assume few planted or volunteer woody species will have attained a height of 6m or a dbh of 10cm, the definition of a tree in the HGM Guidebook.

Using the preceding assumptions and on-site reference wetlands, raw data, sub-indices, FCIs, and FCUs can be estimated with some certainty. This exercise reveals a predicted FCI for on-site restored wetlands at the conclusion of the five-year monitoring period to be 0.56 (Table 3). With the 446.4 acres available for restoration, the FCU value is thus 249.97. Subtracting the 392.89 FCUs impacted in the mining process from the restoration value leaves a deficit of 142.92 FCUs (Table 4) to be mitigated for off-site.

3.2 Off-site mitigation

After communication with United Minerals, four sites already under ownership were identified as potential mitigation. Eco-Tech staff identified an additional property (with three separate plant communities) presumed under ownership with potential for enhancement. A description of each site follows and data is included in Tables 2 and 3.

Table 2. Summary of data collected and measured for the potential mitigation sites. Measured values, sub-indices (in bold), and FCIs are included. On-site mitigation is expected to have an FCI value of 0.0 post-mining and is not evaluated in this table.

	Off-site Areas					
Parameter	**MIT 1 (PFO)**		**MIT2 (PEM)**		**MIT 3 (PFO)**	
Vtract (ha)	890	**0.70**	890	**0.70**	890	**0.70**
Vcore (%)	47	**1.00**	47	**1.00**	47	**1.00**
Vconnect (%)	72	**1.00**	72	**1.00**	72	**1.00**
Vslope (%)	0.003	**1.00**	0.003	**1.00**	0.003	**1.00**
Vstore	125	**1.00**	125	**1.00**	100	**1.00**
Vmacro (%)	6	**1.00**	6	**1.00**	6	**1.00**
Vfreq (yrs)	1	**1.00**	1	**1.00**	1	**1.00**
Vrough (n)	0.14	**1.00**	0.19	**1.00**	0.17	**1.00**
Vsoilint (%)	0	**1.00**	0	**1.00**	0	**1.00**
Vwtf (P or A)	P	**1.00**	P	**1.00**	P	**1.00**
Vwtd (in)	1	**1.00**	1	**1.00**	2	**0.00**
Vwtslope (%)	50	**0.50**	89	**0.10**	90	**0.10**
Vsoilperm (in/hr)	0.4	**0.70**	0.4	**0.70**	1.4	**0.70**
Vpore (%)	43.5	**1.00**	43.5	**1.00**	43.5	**1.00**
Vsurfcon (%)	100	**0.00**	100	**0.00**	100	**0.00**
Vclay (%)	0	**1.00**	0	**1.00**	0	**1.00**
Vredox (P or A)	P	**1.00**	P	**1.00**	P	**1.00**
Vtba (m^2 / ha)	17.8	**0.90**	0.0	**0.00**	21.6	**1.00**
Vtden (stems/ha)	300	**0.80**	0	**0.00**	450	**1.00**
Vsnag (snags/ha)	25	**1.00**	0	**0.00**	25	**1.00**
Vwd (m^3 /ha)	36.2	**1.00**	14.2	**0.75**	53.3	**0.95**
Vlog (m^3 /ha)	17.5	**1.00**	0.0	**0.00**	17.5	**1.00**
Vssd (stems/ha)	500	**1.00**	1,000	**0.50**	1,850	**0.50**
Vgvc (%)	100	**0.10**	100	**0.10**	30	**0.90**
Vohor (%)	100	**1.00**	100	**1.00**	75	**1.00**
Vahor (%)	25	**0.30**	50	**0.60**	100	**1.00**
Vcomp (%)	56	**0.55**	75	**0.70**	83	**0.80**
FUNCTION 1	**1.00**		**1.00**		**1.00**	
FUNCTION 2	**0.80**		**0.63**		**0.63**	
FUNCTION 3	**0.72**		**0.49**		**0.89**	
FUNCTION 4	**0.91**		**0.95**		**0.50**	
FUNCTION 5	**1.00**		**1.00**		**1.00**	
FUNCTION 6	**0.00**		**0.00**		**0.00**	
FUNCTION 7	**0.84**		**0.59**		**0.77**	
FUNCTION 8	**0.90**		**0.48**		**0.95**	
MEAN	**0.77**		**0.64**		**0.72**	

Table 3. Predicted functional values post-restoration/enhancement at the conclusion of five-year monitoring period. Measured values, subindices (in bold), and FCIs are included.

	On-Site Area		Off-site Areas					
Parameter	**Estimated**		**MIT 1 (PFO)**		**MIT 2 (PEM)**		**MIT 3 (PFO)**	
Vtract (ha)	890	**0.70**	890	**0.70**	890	**0.70**	890	**0.70**
Vcore (%)	47	**1.00**	47	**1.00**	47	**1.00**	50	**1.00**
Vconnect (%)	72	**1.00**	72	**1.00**	72	**1.00**	72	**1.00**
Vslope (%)	0.003	**1.00**	0.003	**1.00**	0.003	**1.00**	0.003	**1.00**
Vstore	146	**1.00**	125	**1.00**	125	**1.00**	100	**1.00**
Vmacro (%)	6	**1.00**	6	**1.00**	6	**1.00**	6	**1.00**
Vfreq (yrs)	1	**1.00**	1	**1.00**	1	**1.00**	1	**1.00**
Vrough (n)	0.08	**0.80**	0.14	**1.00**	0.19	**1.00**	0.17	**1.00**
Vsoilint (%)	100	**0.10**	0	**1.00**	0	**1.00**	0	**1.00**
Vwtf (P or A)	P	**1.00**	P	**1.00**	P	**1.00**	P	**1.00**
Vwtd (in)	1.0	**1.00**	1.0	**1.00**	1.0	**1.00**	1.0	**1.00**
Vwtslope (%)	10	**0.90**	34	**0.56**	40	**0.60**	51	**0.49**
Vsoilperm (in/hr)	SM	**0.10**	0.4	**0.70**	0.4	**0.70**	1.4	**0.70**
Vpore (%)	SM	**0.10**	43.5	**1.00**	43.5	**1.00**	43.5	**1.00**
Vsurfcon (%)	50	**0.50**	50	**0.50**	50	**0.50**	50	**0.50**
Vclay (%)	50	**0.50**	0	**1.00**	0	**1.00**	0	**1.00**
Vredox (P or A)	P	**1.00**	P	**1.00**	P	**1.00**	P	**1.00**
Vtba (m^2 / ha)	2.0	**0.10**	20.0	**1.00**	2.0	**0.10**	25.0	**1.00**
Vtden (stems/ha)	100	**0.25**	400	**1.00**	200	**0.50**	450	**1.00**
Vsnag (snags/ha)	0	**0.00**	25	**1.00**	15	**0.50**	25	**1.00**
Vwd (m^3 /ha)	2.0	**0.10**	40.0	**1.00**	10.0	**0.50**	55.0	**0.95**
Vlog (m^3 /ha)	0.0	**0.10**	20.0	**1.00**	5.0	**0.50**	20.0	**1.00**
Vssd (stems/ha)	750	**0.50**	500	**1.00**	500	**1.00**	500	**1.00**
Vgvc (%)	90	**0.20**	50	**0.60**	50	**0.65**	30	**0.90**
Vohor (%)	20	**0.30**	100	**1.00**	100	**1.00**	75	**1.00**
Vahor (%)	0	**0.00**	25	**0.30**	50	**0.80**	100	**1.00**
Vcomp (%)	50	**0.50**	90	**0.90**	90	**0.90**	100	**1.00**
FUNCTION 1	**0.95**		**1.00**		**1.00**		**1.00**	
FUNCTION 2	**0.43**		**0.81**		**0.82**		**0.79**	
FUNCTION 3	**0.20**		**0.82**		**0.68**		**0.98**	
FUNCTION 4	**0.67**		**0.91**		**0.97**		**1.00**	
FUNCTION 5	**0.95**		**1.00**		**1.00**		**1.00**	
FUNCTION 6	**0.38**		**0.84**		**0.73**		**0.83**	
FUNCTION 7	**0.49**		**0.97**		**0.77**		**1.00**	
FUNCTION 8	**0.45**		**0.96**		**0.72**		**0.97**	
MEAN	**0.56**		**0.91**		**0.84**		**0.95**	

Site MIT 1 (120 acres)

This site is located in a partially forested wetland west of and adjacent to Pigeon Creek. To the south it borders the Seven Hills permit area. The site has been selectively logged, with non-commercial species left standing in a largely open arrangement. Logging debris and equipment surface disturbances are evident. A natural stream channel has been channelized and cut to Pigeon Creek. An FCI of 0.77 was calculated at the site. Total FCUs at Year 0 are therefore 92.40. Enhancement initiatives at this site would consist of the planting of native tree and shrub species to supplement the existing low quality overstory seed trees. Drainage features may be reconnected to natural channels fostering improvement in site hydrology. With these proposed actions, post-monitoring (Year 5) FCI is estimated at 0.91, resulting in 109.20 FCUs. This represents an increase of 16.80 FCUs.

Site MIT 2 (50 acres)

Site 2 is located adjacent to and west of Pigeon Creek, lying just north of the Seven Hills permit area and south of Stanley Road. It has been clearcut within the last two years and currently exists as an emergent wetland with numerous volunteer soft mast seedlings. A small forested parcel (7 acres) remains in a remnant swale and is not considered further in this assessment. Soil disturbance is evident at the surface with numerous tire/track ruts, and drainage alterations. An FCI of 0.64 was calculated at the site. Total FCUs at Year 0 are therefore 32.00. With the implementation of a high quality tree/shrub planting scheme and the reconnection of minor drainage features to their natural channels, post-monitoring (Year 5) FCI is estimated at 0.84, resulting in 42.00 FCUs. This represents an increase of 10.00 FCUs.

Site MIT 3 (80 acres)

This forested property is located south of Booneville New Harmony Road along Towpath Road. It sits at the confluence of Squaw Creek and Pigeon Creek and is just east of the abandoned Eerie and Wabash Canal. This 80-acre parcel is surrounded largely by open water dead tree swamps caused by elevated berms and roads along the canal. From aerial photographs in the Warrick County Soil Survey, the site has been farmed as recently as 1979. Remnant agriculture drainage ditches and furrowing are present. Both Squaw Creek and Pigeon Creek are deeply channelized and straightened, the lateral effects of which stretch across the site. An FCI of 0.72 was calculated at the site. Total FCUs at Year 0 are therefore 57.60. With the implementation of a tree/shrub planting scheme and the reconnection of drainage features to their natural channels, post-monitoring (Year 5) FCI is estimated at 0.95, resulting in 76.00 FCUs. This represents an increase of 18.40 FCUs.

Site MIT 4 (N/A)

The area, south of I-64 near Elberfeld, is upland and is not suitable for wetland creation or restoration.

Site MIT 5 (N/A)

This site is a forested wetland east of Pigeon Creek and south of Seven Hills Road. Portions of the area could be enhanced with vegetation plantings and thinning to improve species composition. However, a new bridge crossing and approach right-of-way have been surveyed and staked, presumably by the Indiana Department of Transportation or Warrick County Department of Highways. Because of the planned roadway construction this site is not recommended for mitigation.

Site MIT 6 (N/A)

This site consists of upland old field pasture and high quality bottomland forested wetland. This site may be considered for preservation (location of Indiana bat maternity colony), but it cannot be substantially improved.

4 Compensatory Mitigation Analysis

The HGM approach used for this project forms the framework for a science-derived tool to be used in estimating mitigation needs, land acquisition/allocation, and, ultimately, a cost/benefit analysis of alternatives. The question at the heart of most mitigation planning ventures is "Is it more beneficial to enhance many already-owned wetland acres or purchase and fully restore substantially less acreage?" Table 4 incorporates data collected during all phases of the project into a simple analysis tool.

Table 4. Compensatory mitigation analysis for the Seven Hills Permit Area using the HGM approach.

	Area (ac)	Current FCI	Current FCU	Pre-mon (Yr 0) FCI	Pre-mon (Yr 0) FCU	Post-mon (Yr 5) FCI	Post-mon (Yr 5) FCU	FCU Change	FCU Net Balance
On-site	446.4	0.88	392.89	0.00	0.00	0.56	249.97	-142.92	-142.92
MIT 1	120.0	0.77	92.40	0.77	92.40	0.91	109.20	16.80	-126.12
MIT 2	50.0	0.64	32.00	0.64	32.00	0.84	42.00	10.00	-115.98
MIT 3	80.0	0.72	57.60	0.72	57.60	0.95	76.00	18.40	-97.58
Total	**703.4**		**580.63**		**187.74**		**483.05**	**-97.58**	**-97.58**

For the sites visited, a few general statements can be made.

- Supplemental woody vegetation planting as part of enhancement strategies alone does not make a substantial difference in the overall wetland function over a five year monitoring period (increase of approximately 0.1 FCI).

- Restoration of altered drainage channels within an existing wetland may increase function from about 0.05 to 0.20 FCI depending on the degree of alteration.

- Full-scale restoration of an altered site to a historic wetland condition, which incorporates hydrology, soil, and vegetation considerations, can increase the function 0.5+ FCIs depending on the degree and duration of the original impact.

- Additional gains in functional capacity may be realized with the targeted management of ideal (sub-index =1.0) plant density, dominant species composition, snag density, woody debris occurrence, and ground vegetative cover. This may require annual maintenance at certain sites.

5 Conclusions

The Pigeon Creek HGM evaluates wetland functions by measuring parameters of the community's vegetation, hydrology, soils, and the surrounding landscape. The method provides a quantitative measure of wetlands that is a useful tool for wetland restoration, creation, enhancement, and monitoring.

The Functional Capacity Unit provides an effective, quantifiable tool to evaluate wetland credits for creation, enhancement, and restoration efforts. While enhancement of existing wetlands is an accepted compensatory practice, little functional gain is expected at 5 years. Using a maximum figure of approximately 0.2 FCU gain, off-site acreage needed will be on the order of 750 acres. Conversely, full-scale restoration may provide a maximum FCU gain of approximately 0.6 FCU, with total acreage needed of 250 acres.

Traditionally, mitigation plans have incorporated standard ratios in the mitigation analysis. Impacts to mature forested wetlands may require 2:1 to 3:1 replacement. Using the calculated permit area wetland impacts of 446 acres, we would expect off-site restoration need to be on the order of 450 acres. Enhancement ratios and acreage would be substantially higher (>5:1). Assuming this to be the goal to satisfy traditional compensation policies within the regulatory climate, we can show with this functional analysis that we are meeting and exceeding the stated goal of replacement of lost functions and values. Additionally, it provides a tool to counter aggressive mitigation requirements greater than 2:1. Of course all of this assumes that sound restoration practices are initiated and success criteria are met.

In our opinion, the mitigation plan should target true restoration sites within the Pigeon Creek sub-basin. This is most cost-efficiently accomplished by negotiating easements or fee-simple purchase of prior-converted farmland. Generally, artificial drainage (ditches, tiles, etc.) is easily corrected, earthwork is restricted to roughness dress work, the subsoil remains intact, large single tracts may be available, and maximum restoration credit may be obtained. Any other considerations may alter potential function gain and be met with resistance from regulatory agencies.

Appendix A

Site Maps

Legend

- Mitigation sites
- Permit Boundary
- Wetland Tract

STATE OF:	**Indiana**
COUNTY OF:	**Warrick**
SCALE:	1:60,000

FIGURE 1. LOCATION OF POTENTIAL MITIGATION SITES FOR THE SEVEN HILLS SURFACE MINE

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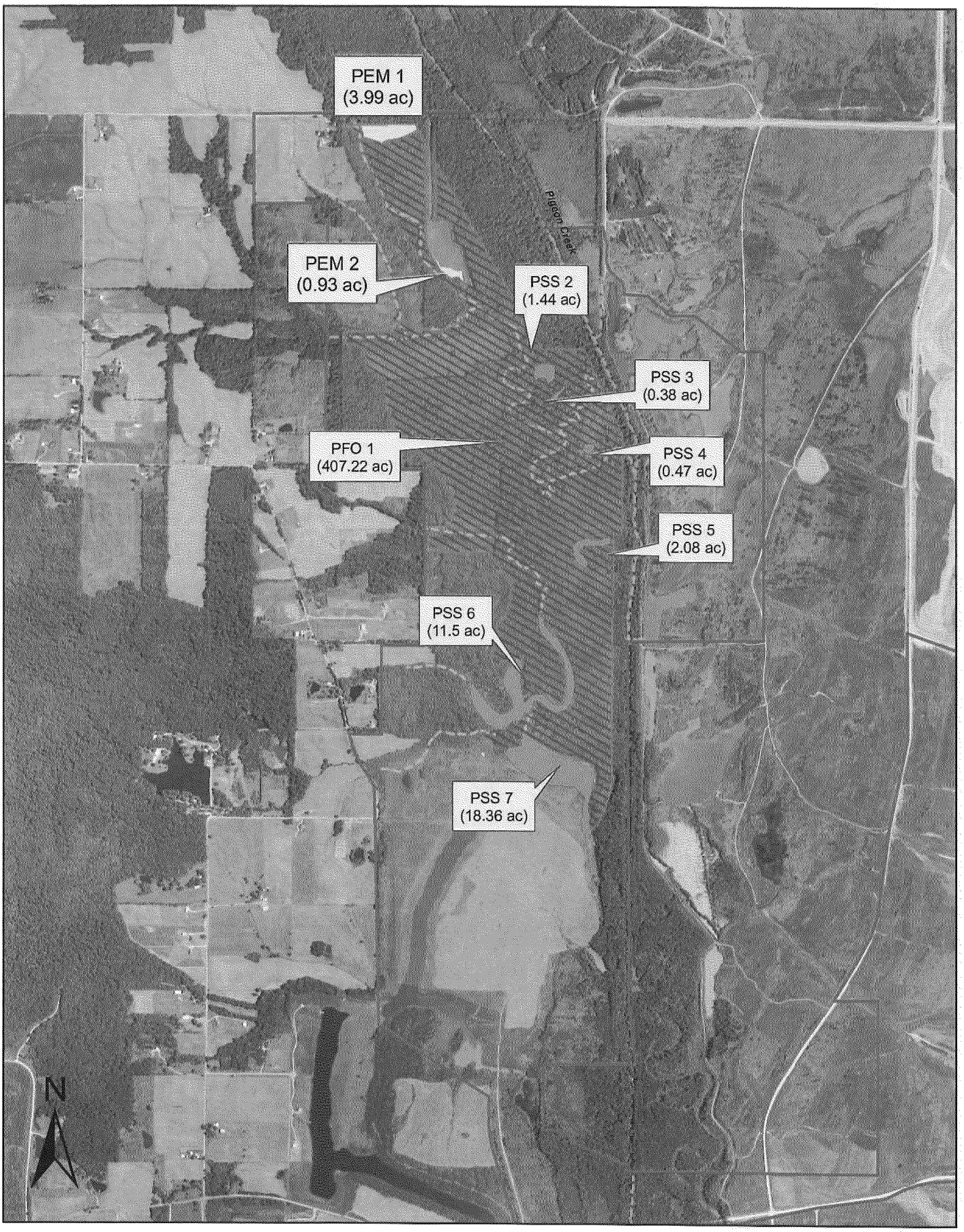

Legend

- PEM Impact
- PSS Impact
- PFO Impact
- Impact Area
- Permit Boundary

STATE OF: **Indiana**

COUNTY OF: **Warrick**

SCALE: 1:24,000

FIGURE 2. LOCATION OF IMPACTED WETLANDS AND STREAMS FOR THE SEVEN HILLS SURFACE MINE

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Appendix B

Site Photographs

MIT 1 (PFO). Mean FCI is 0.78.

MIT 2 (PEM). Mean FCI is 0.67.

MIT 2 Beaver dam

MIT 2 Roadside ditch cutting to Pigeon Creek grade

MIT 3 (PFO) Mean FCI is 0.75. Notice drainage swale in background.

MIT 3. Drainage ditch adjacent to wetland.